Spring 2019

# Lithic Production Technologies at the Louisville Swamp Site

Avery Marshall

# Lithic Production Technologies at the Louisville Swamp Site

Avery Marshall

An Honors Thesis
Submitted as requirement for graduation with honors in Anthropology from
Hamline University

April 26, 2019

# Table of Contents

# Tables



# Table of Figures

# Abstract

The landscape of the Minnesota River Valley of central Minnesota holds rich archaeological and historical evidence of human occupation extending over the last 10,000 years. Two seasons of archaeological fieldwork by Hamline University and the US Fish and Wildlife Service have begun exploring the Louisville Swamp Unit of the Minnesota River Valley National Wildlife Refuge in Shakopee. One of the most important discoveries of this fieldwork was a Woodland tradition lithic (or stone) workshop (ca. 500-1500 CE). Excavations at this site have produced thousands of artifacts demonstrating the workshop was primarily utilized for making stone tools of Prairie du Chien (PDC) chert. PDC chert is a stone material considered of only moderate quality for flint knapping but which can be easily procured in large quantities from the outcroppings in the surrounding landscape. This workspace is where flintknappers tested and heat treated lithic raw materials so they could be worked into stone tools for everyday use. The artifacts recovered include lithic debris (flakes, tested raw materials, broken chert, etc.), fire-cracked rock, burnt limestone, hammerstones, an anvil, and several pieces of grit tempered pottery. In recording flake attributes such as platform angle, size grade, weight, etc. of this lithic assemblage, we can better grasp aspects of how the ancient flintknappers were able to effectively exploit this abundant raw material. The comparison of the debitage analysis results at the Louisville Swamp Site to other archaeological pre-contact lithic sites in Minnesota helps us understand the production stages and techniques of stone tool manufacturing, especially in relation to the thermal alteration of PDC chert, these results also lend themselves to the investigation of the production stages in which PDC chert is transported across Native Southern Minnesota landscapes.

# Introduction

This thesis uses archaeological artifacts and research methods to understand the lithic remains of a pre-contact site in the Louisville Swamp Unit of the the US Fish and Wildlife Service's (USFWS) Minnesota Valley Wildlife Refuge is located in Shakopee, Scott County, Minnesota.

The wildlife refuge was established in 1976 as a sanctuary for migratory waterfowl and non-migratory fish. In total, the refuge spans from Bloomington to Henderson, Minnesota, and houses a number of units totaling over 14,000 acres (USFWS website). The Louisville Swamp Unit (2,600 acres) is quite diverse in its environment as it houses a restored prairie, an oak savanna habitat, wetlands and many other ecosystems that cover terraces, ravines, and shoreline (USFWS Louisville Swamp Unit Trail Map; Wikipedia Contributors 201).

James Myster, Historic Preservation Officer and Archaeologist of Region 3 of the US Fish and Wildlife Service (USFWS), manages the cultural resources of this refuge, which includes the archaeological record of this landscape. Phase I and II archaeology was conducted in collaboration with the USFWS and Hamline University's Anthropology Department as a way to investigate and preserve the cultural histories and resources present in this landscape. This unit has also undergone environmental preservation as its oak savanna habitats have scheduled controlled burns and the unit saw a recent prairie restoration project (James Myster, personal communication 2017).

The archaeological survey located a lithic workshop space on the lower shoreline of a ravine, adjacent to the Louisville Swamp. In our initial debitage analysis in fall of 2017, there was an unusual amount of Prairie du Chien (PDC) chert in the lithic assemblage with little context for how the material was sourced and prepared for further reduction. This research seeks to understand how flintknappers at the swamp were exploiting this raw material and through what technologies. Specifically, I hope to place the debris of this lithic workshop within the lithic reduction sequence by utilizing the results of debitage analysis from the Louisville Swamp assemblage and comparing them to lithic sites in Cottonwood County, Minnesota.

More broadly, this thesis supports Hamline University's Archaeology Lab and colleagues' larger research initiative focused on lithic materials in Southwestern Minnesota on the Red Rock Ridge and the Jeffers Petroglyphs. This project supports their goal of understanding how PDC chert moves across Native landscapes in Southwestern because it is not local to the area.

# *Louisville Swamp Site Map*


*Figure 1: Louisville Swamp Site area map. The location of the site cannot be publically disclosed for the site's protection. For access to the site's location, contact  the USFWS.*

# *Background*

## *Land formation and Geological History*

Minnesota's glacial history is important to understanding the Louisville Swamp landscape. Massive glacial ice sheets expanded and retreated repeatedly across central Minnesota over 2 million years (Ojakangas and Matsch 1982: 16). These ice sheets left behind sediment present in today's soils and exposed outcroppings of bedrock that has allowed people access to lithic raw materials such as PDC chert and shaped much of the upland topography.

The the Minnesota River Valley was created by glacial activity. Glacial Lake Agassiz once covered parts of Northern Minnesota, North Dakota, Manitoba, and Ontario. Glacial Lake Agassiz was created by the melting of the Des Moines lobe and drained through the Traverse Gap (in what now would be Western Minnesota) (Ojakangas and Matsch 1982: 109, 233). It then fed the Glacial River Warren, which carved the Minnesota River Valley (Gibbon 2012: 28; Wikipedia Contributors 2018). Today, the Minnesota River flows through a portion of the five-mile-wide valley carved by the Glacial River Warren before flowing into the Mississippi River at Bdote in Ramsey, Dakota, and Hennepin Counties, Minnesota. Its total length is 332 miles (Wikipedia 2018).

The soil of this landscape is essential to understanding the parameters of land usage throughout time. The United States Department of Agriculture's Soil Conservation Service Survey, in cooperation with the Minnesota Agricultural Experiment Station surveyed Scott County in 1955. They classify the soil and sediment of the Louisville Swamp Unit as having sandstone outcrops on lower terraces with residuum being the parent material. The land above the ravine is terraced and is classified as stony and with glacial till as the parent material and is not fit for agricultural purposes because of this (USDA, SRS, MAES 1955: 21).

Additionally, the historic vegetation of the wildlife refuge explains the resources available to people living in and using the landscape. *The Original Vegetation of Minnesota* map (Marschner 1974) identifies the environment of the Louisville Swamp as being primarily River Bottom Forest with spots of Big Wood forests. River Bottom Forests are located on floodplains and valley bottoms, which is in line with the landscape of the Minnesota River Valley (Marschner 1974). These forests include Elm, Ash, Cottonwood trees and others. Big Wood forests are upland hardwoods forests and include Oaks, Elm, Basswood, Ash, Maple trees, and others (Marschner 1974). The historic fauna of this landscape were primarily game animals such as white tailed deer, elk, black bear, raccoon, squirrel, opossum, and others (Gibbon 2012: 21).

Glacial activity is key in understanding the geological resources of the Louisville Swamp Unit of the Minnesota River Valley National Wildlife Refuge. Ojakangas and Matsch (1982: 233) vaguely place Northwestern Scott County in the southeastern geological region of the Minnesota. They describe the bedrock outcroppings of this region to be result of glacially eroded upper layers of sediment, such as St. Peter Sandstone, that exposes the dolomite (often Prairie du Chien) below and is covered with glacial deposits of the Pleistocene and Holocene Epochs (1982: 234). These bedrock outcroppings are crucial to obtaining the primary lithic materials of this region and have been quarried in some areas (Bakken 2011: 91). Minnesota archaeologists note this specific area holding high-quality cherts in its many bedrock outcroppings (Bakken 2011: 91; Gibbon 2012: 27-28). Wright (1972: 564) identifies the physiographic region of the Northwest area of Scott County as being in the Owatonna Moraine area as well as the Minnesota River Valley. The Sand creek follows through the high terraces and the swamp, and continues into the Minnesota River, connecting these landscapes.

Central Minnesota is characterized as the largest lithic resource region with its rolling landscape of deep lakes and wetlands (Gibbon 2012: 25; Wright 1972: 564). Bakken (2011: 65) divides the state of Minnesota into lithic resource regions and calls southeastern Minnesota the Hollandale Resource Region. This region includes east central to southeastern Minnesota, continuing into western Wisconsin and northeastern Iowa. The primary raw materials for this area are PDC, Cedar Valley, Grand Meadow, and Galena cherts, with Hixton Group Quartzite being the most notable exotic to the region (Bakken 2011: 91). In the Northern and Northwestern edges of the Hollandale Resource Region, PDC chert is the most important lithic raw material with Cedar Valley and Grand Meadow cherts being key in the South-central portion and Galena chert in the Southeast (Bakken 2011: 92). The maximum percentage for PDC chert in a lithic assemblage from this region is ninety-one percent (Bakken 2011: Table 3-4).

Prairie du Chien (PDC) chert is found in a geological group of dolomite formations that hold chert deposits (see Figure 1) (Wendt 2014: 2). Each type of PDC chert has a distinct sediment composition caused by water movements (Wendt 2014: 2). Both dolomite formations are associated with the Ordovician geological period (Ojakangas and Matsch 1982: 11, 68). Within the PDC chert group, there are two dolomite formations: Shakopee and Oneota (Wendt 2014: 2).

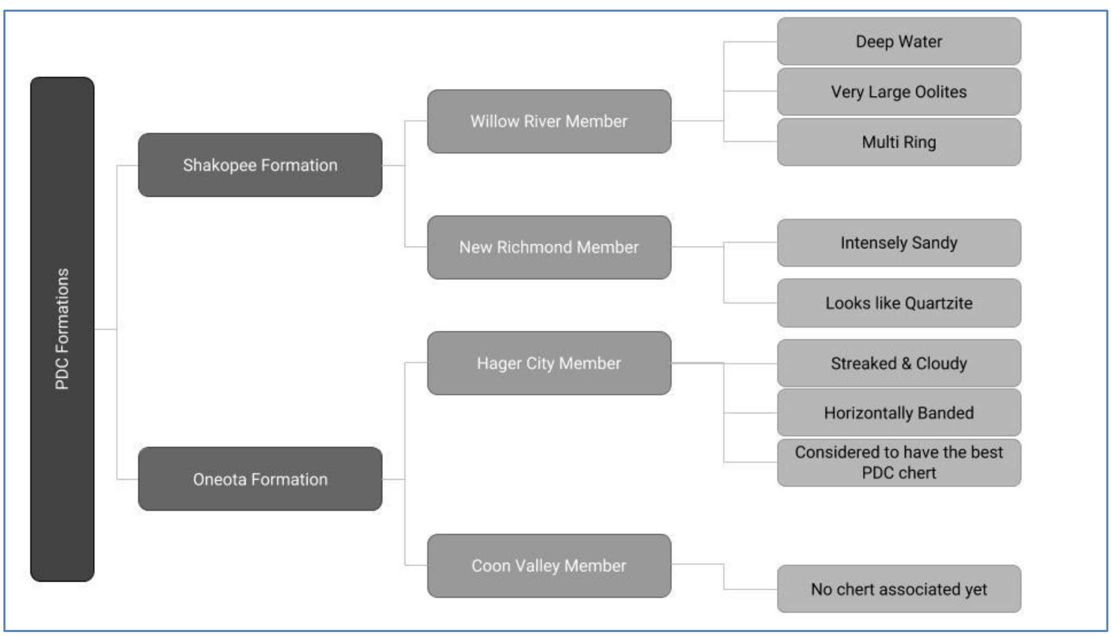


*Figure 2: Schematic chart of PDC chert formations with their visible attributes (informed by Wendt 2014, personal communication 2019).*

The Shakopee formation holds the Willow River and New Richmond members, and the Oneota formation holds the Hager City and Coon Valley members (Wendt 2014: Table 1). Coon Valley is not yet associated with known chert deposits (Dan Wendt, personal communication 2019). There is much variation in quality between these formations, and even their members.

Wendt's research on the ease of knapping Minnesota raw materials into bifaces places the PDC chert within the Shakopee Formation as among the most difficult material to work because of its coarse structure (Wendt, personal communication). The Shakopee formation is difficult to thin due to its grainy structure, and thus not ideal for biface reduction (Dan Wendt, personal communication 2019). Heat treatment (the process of thermally altering raw materials) can help improve the crystalline structure and make the material more workable but is difficult to identify through visible attributes alone (Bakken 2015: 250; Wendt 2014: 4). Wendt (personal communication, 2019) reports that the Shakopee formation of PDC chert is only slightly improved by heat treatment and is still difficult to work.

## *Cultural Contexts*

Minnesota's Indigenous and colonial histories are key to understanding the cultural influences present at the Louisville Swamp when the lithic workshop was active. This section will discuss the major patterns and diagnostic elements of Minnesota's prehistoric cultures (Paleoindian, Archaic Tradition, Woodland Tradition, Mississippian and Plains Indians) and early historic periods.

The Paleoindian period (10,500 to roughly 8000 BC) is widely accepted as the earliest cultural tradition established in North American (Gibbon 2012: Figure I.1). This Tradition has three major cultures found in Minnesota: Clovis, Folsom, and Plano (or late Paleoindian). All of these are associated with the characteristic lanceolate shaped points of the Paleoindian Tradition. Clovis culture is the oldest with the introduction of the fluted point (the middle of the point being longitudinally flattened) for spear-hunting (Minnesota Office of the State Archaeologist [Minnesota OSA] 2016). Folsom culture projectile points are smaller with flute being the majority of the point's surface area. Plano culture, or Late Paleoindian culture marks the transition out of the fluted point in stone tool production (Minnesota OSA 2016). The people of this tradition were mainly big-game hunters that navigated the Late Glacial geological stage (Gibbon 2012: 37-38).

The Archaic Tradition (7,000 BC to 500 BC) is when Native American groups moved out of the Paleoindian style point and into a variety of projectile points to serve different purposes and create a diversified hunter-gatherer economy (Gibbon 2012: 65, Figure I.1). This tradition begins with the end of the Early Holocene and shifts with the Middle and Late Holocene near the transition to Woodland Tradition (Gibbon 2012: 66). The Archaic Tradition is broken into regional subcultures in Minnesota based on the differing environments: the Southwest part of the state is the Prairie Archaic, the Lake Forest in Central and North Central, the Shield Archaic in the far Northeast area of Minnesota, and the Riverine in the Southeast.

Many points are specifically made for atlatl usage and darts typically are smaller with basal notching. The Archaic Tradition is when horticulture becomes a normative practice. Due to the change of the forests and the rise in temperature, bison hunting is a primary objective. At the Louisville Swamp, this change is the area being on the border of Spruce and Oak Elm forests to completely within the Oak Elm region (Gibbon 2012: 42-43). Ground stone tools are introduced to lithic production at this time as well (Minnesota OSA 2016). Gibbon (2012: 66) identifies this era as lacking “both Paleoindian projectile points and pottery and dates roughly before 500 BC.”

The Late Archaic Tradition’s identifiers have some overlap with the Woodland Tradition, with burial mound building, horticulture, and pottery; however, the Woodland Tradition is classified as having the first pottery vessel production (Gibbon 2012: 93). These shared diagnostic artifacts serve to show how fluid pre-contact Native American cultures were. Like other cultural periods, the Woodland Tradition is separated into different stages. Some archaeologists use Early, Middle, and Late Woodland, based on cultural changes. I will be following Guy Gibbon’s identification of Initial and Terminal Woodland Traditions.

Although there are regional differences for these two periods within the Woodland Tradition, Initial Woodland (1,000 BC to 500 BC to AD 500-700) has thick-walled and coarse tempered pottery vessels (Gibbon 2012: 96) with specific types of pottery in different regions. Terminal Woodland Tradition (AD 500 to 1200) shows increased use of horticulture for subsistence and the production of associated tools, as well as thinner pottery vessels with finer tempers (Gibbon 2012: 137-138, Figure I.1). Effigy mounds are also diagnostic of the Terminal Woodland (Gibbon 2012: 141). Wild rice harvesting and processing is a huge aspect of the food systems for Northern Native peoples. Additionally, in Southeastern Minnesota evidence of settled agricultural practices is found with respect to the three sister crops (corn, beans, and squash) on fertile bottomlands (Minnesota OSA 2016). Projectile points are smaller than previous cultural traditions with side and corner notching and are used for archery hunting (Minnesota OSA 2016). There are three main cultures associated with Woodland Tradition occupations in Central Minnesota: Malmo, St. Croix, and Onamia (Minnesota OSA 2016).

Native Americans in the Mississippian (AD 1050 to 1200) and Plains Village (AD 950 to 1200) cultures were more settled with horticulture-based occupation patterns with utilization of maize and more hierarchical social organization than previous cultures (Gibbon 2012: 159, Figure I.1). The pottery manufacturing became more homogeneous with a switch to shell temper and smoothed surfaces with decorations on the shoulders rather than the rims. Handles also became a norm in pottery vessels. (Gibbon 2012: 159).

In 1300 AD the ancestral Dakota/Lakota/Yankton peoples in central Minnesota became the People of the Seven Council Fires (Gibbon 2003: 45). This involved the implementation of more territorial village settlements with established leadership hierarchies (46). Native peoples were pushed west as European settlers begin colonizing North America, which made for the concentration and movement of Native groups across North American landscapes. The Ojibwe were pushed to the north of Minnesota, pushing the Dakota into the central and southern regions of Minnesota. In the landscape of the present day Louisville Swamp Unit, artifacts and burial mounds marked a village that probably belonged to the Wahpeton Dakota's ancestors (Spector 1993: 42).

The Minnesota River Valley has been the home to Native peoples for thousands of years. Spector (1993:42) dates the beginnings of the Wahpeton Dakota village to 1800 at the latest and was established just before the rush of white settlement. A fur trading post was established by Jean-Baptiste Faribault in close proximity to the swamp and Inyan Ceyaka Atonwan (village at Little Rapids) in the early nineteenth century which allowed for a larger economy of goods (Spector 1993: 43; Wikipedia Contributors 2019). In historic times, Louisville Swamp Unit of the Minnesota Valley National Wildlife Refuge holds ties to great Eastern Dakota leaders and their villages, specifically Chief Mazomani. Chief Mazomani, or Chief Walking Iron, negotiated many of the treaties between the Wahpeton Dakota peoples and the United States government in the mid-1800s (Shakopee Mdewakanton Dakota Sioux Community, n.d.; Spector 1993). The Treaty of Traverse des Sioux in 1851 dictated that the Wahpeton Dakota be removed from their homelands and placed onto reservations owned by the federal government in Western Minnesota. Today, the Shakopee Mdewakanton Sioux Community are the nearest sovereign Indigenous nation to both the historic Wahpeton Dakota Village and the Louisville Swamp Site. The Upper and Lower Sioux Communities are also associated with these cultural sites as their ancestors were displaced from their homelands (SMDC n.d.).

Archaeological work has been conducted in this landscape to understand its Native American and historic era occupations and narratives. Hudak (1989) identified a site with pre-contact artifacts that was later given the alpha site designation 21SCaa. The site is located in the center of the southeastern quarter of section 29 of township 115 North and range 23 West. It was identified as a pre-contact habitation site (21SCaa Site Form). In the early 1980s, Dr. Janet D. Spector conducted fieldwork on a historic Wahpeton Dakota village at the Little Rapids Village (21SC27). This village is located just across the swamp from the Louisville Swamp Site test units. In her book, *What this Awl Means: Feminist Archaeology at a Historic Wahpeton Dakota Village* (1993), Spector gives context to the practices of this seasonal Dakota planting village. Her archaeological project used an indigenous feminist epistemology to understand the era of early colonial settlement in relation to the site and the artifacts recovered. It is interesting to compare this 19th century narrative against the Woodland Tradition lithic workshop site at Louisville as together they highlight the variety and span of land usage in this area. This all comes together to inform archaeologists today how this landscape was conceptualized and utilized by its past occupants.

The site at Louisville Swamp is called Ravine East (21SCaa) and for the purposes of this paper, I will refer to it as the Louisville Swamp site. It is representative of the Woodland Tradition (800 BC to 1700 AD) and can be associated with Paleoindian occupations as well. Although the site is not identified as Paleoindian, a midsection of a fluted point was excavated in the 2017 field season (Figure 2). This is the only artifact of its kind and could be the result of past occupants or recycled stone tools. Woodland Tradition was confirmed at this site because of the small (under 2 centimeters in total length), grit tempered pottery sherds recovered in both seasons of excavation. Because analysis has not been conducted on the handful of pottery sherds recovered and the lack of key diagnostic artifacts, we are not able to place the Louisville Swamp Site within a specific time frame of the Woodland Tradition.


*Figure 3: Midsection of fluted point associated with Paleoindian Tradition. Raw material not identified. Recovered from shovel test 6.7 in June of 2017.*

## *Chipped Stone Technology, Raw Material Procurement, and Debitage*

Chipped stone technology is one of the most common ways to produce stone tools and can account for the majority of the production of pre-contact stone tools in archaeological assemblages in North America. Chipped stone tools are produced by flintknappers, or people who use forceful strikes to reduce and shape lithic raw material into the desired tool or form (Whittaker 1994: 11-12). The debris removed are called flakes or debitage, and are considered the waste of patterned reduction in chip stone technology (Shott 1994: 69-70). This waste material is not as valued as the desired end product and is often discarded in the same space it was produced, leaving unbiased data for archaeologists to assess (Shott 1994: 70-71).

Lithic debitage has a specific anatomy as a result of reduction technology and the morphology of the material. Complete flakes have an intact striking platform at the proximal end where the material was hit to detach the flake from the core (Shott 1994: 70, 78; Sullivan and Rozen 1985). Great force is needed to detach a flake from its core, and evidence of this is in the bulb underneath the platform where this force is absorbed. The bulb is on the ventral surface (or belly) of the flake and is the fresh surface that is created when the flake is detached from the core. At the distal end of the flake is the termination (or end) of the flake. On the dorsal side (or pre-existing side) of the flake, it is likely to find cortex indicating an earlier-stage reduction or flake scars from previous reduction.

Flintknappers use a variety of lithic raw materials based on the materials available through trade, travel, or local procurement but tend to seek raw materials with homogeneous crystalline structures (Whittaker 1994: 65-66). Amorphous crystalline structures such as obsidian are noted by Whittaker (1994: 66) to be ideal for working but fault on their durability compared to cryptocrystalline cherts. The least ideal raw materials to work are those with coarse and grainy structures (Whittaker 1994: 66). This description aligns most with the majority of the lithic assemblage from the Louisville Swamp as much of the PDC chert has visible sandy oolites and is not consistently homogeneous.

Lithic raw material was obtained by ancient flintknappers in a number of fashions, and is crucial to our central research question of how people were exploiting PDC chert at the Louisville Swamp. Kent Bakken (2015: 233) establishes two initial raw material sourcing types: focal and diffuse. Focal sourcing refers to raw materials that have defined boundaries and limits within a landscape whereas diffuse sourced raw materials are more fluid in their location and availability, typically being more abundant than focal materials. The second distinction Bakken (2015: 233) notes is primary and secondary geological sources. Primary sources contain lithic materials in the geological context of their formation. Secondary sources contain lithic materials that have been removed from their primary source to another location such as glacial till or river gravels. The Louisville Swamp is a primary source for PDC chert associated with a quarry site.

Assemblages with lithic debris are often associated with a variety of sites that align spatially with lithic reduction, production, and stone tool maintenance including quarries, workshops, lithic scatters, and more. Quarries are point sources for stone extraction and often exhibit signs of extraction and testing (Hiscock and Mitchell 1993: 19). Quarries are typically associated with lithic workshop sites and can be in the close proximity of each other depending on the land usage and technological organization (Hiscock and Mitchell 1993: 20). Reduction sites, or workshops, are spaces where there is evidence of flintknappers working toward a specific objective with respect to the stage or purpose of reduction (Hiscock and Mitchell 1993: 21). These two types of sites are associated with early-stage lithic reduction as the flintknappers are often testing, preparing, and then further working raw materials in these spaces because of their spatial relationship to the material source. Lithic scatter sites are extremely broad in their assemblage patterns and cannot be classified as having a set typology. Tool maintenance associated with pressure flaking should exhibit smaller debitage with higher platform angles as it is like late-stage reduction. These sites are more likely to have exhausted tools in the archaeological record. Lithic scatter and tool maintenance sites with a variety of raw material might be the result of repeated visits to the site over time. Lithic reduction stages for non-tool debitage are first classified by dorsal cortex (outer rind of the material) cover according to Sullivan and Rozen (1985: 756) into three progressive categories: primary, secondary, and tertiary waste. Primary flakes are first to be detached and are majorly cortical on their dorsal side, allowing secondary flakes detached and are are partially cortical with tertiary flakes being last in this progression as completely non-cortical (Sullivan and Rozen 1985: 756). This progression acts as a model for understanding how lithic materials decrease in size and surface area as reduction continues (Sullivan and Rozen 1985: 756).

Bifacial reduction is when material is detached from both faces in opposing directions to shape a preform or refined biface (Whittaker 1994: 23, 201-203; Kelly 1988: 718). Bifacial reduction is critical in the production of projectile points and other stone tools. They important in understanding how lithic raw materials move across landscapes; unworked raw material packages are often too taxing to carry and bifacial reduction is a method of making materials more mobile (Kelly 1988: 718). Additionally, it is noted in the literature that a lack of accessibility to raw materials acts as a “precondition for bifaces as use-life tools” because of their durability (Kelly 1988: 720). Kelly (1988: 718) highlights the work and energy investment that goes into biface production, meaning bifaces have a long life-use and are not likely to be discarded with expedient tools. Maintenance through re-sharpening the high amount of tool edge on a biface makes them easy to preserve (Kelly 1988: 718).

The chipped stone production technologies employed at the PDC chert workshop site at Louisville were essential to Native lifeways. The necessity of these objects is comparable to how we use tools to adapt to our environmental and cultural demands today (Bakken 2011: 1). Through identifying the lithic reduction strategies of this lithic workshop site, we can better understand how flintknappers worked PDC chert and with what intentions.

## *Procurement and lithic strategies*

Minnesotan archaeologists and lithic specialists Kent Bakken and Dan Wendt have laid out their own findings of PDC chert. Wendt (2014: 11) discusses the lack of research and distinction within the archaeological field of the various formations of PDC chert, noting that because of the variety of quality in PDC chert there is little to no evidence of it entering a lithic trade system, making its use primarily localized. PDC chert is noted as being less desirable raw material for flintknapping and can be difficult even after it is heat-treated **(**Withrow 1983: 49).

At the Louisville Swamp, PDC chert is abundant in the bedrock outcroppings along the landscapes shoreline and high terraces. It is assumed PDC chert was quarried in this landscape as well although that is yet to be determined. Much of the cortex present in the Louisville Swamp lithic assemblage aligns with the bedrock and coarse categories and confirms this is a primary raw material to this lithic workshop.

### *Model of Lithic Provisioning*

Four possible sequences following procurement following Hoffman and Seaberg-Wood’s (n.d.) model:

- Model 1: Tested Raw Material Strategy
  - Flintknappers tested cobbles and then removed all workable materials from site.
- Model 2: Core-Flake Strategy

    - Cobbles are worked into cores, which are then reduced to flakes. The usable flakes are moved off-site.
- Model 3: Biface Strategy
    - 3a: Flintknappers produced Early Stage Biface from cobbles and took the bifaces off-site for further working and use.
    - 3b: Flintknappers produced Late Stage Biface from early stage biface and then either finished or used, and discarded the bifaces off-site.
    - 3c: Flintknappers worked the entire lithic reduction sequence from cobble to Finished Biface on site, and then discarded the tool off-site.
- Model 4: Tool resharpening
    - Flintknappers were maintaining tool edge on site and only pressure flaking.

# *Methods*

## *Field Methods*

The debitage analyzed in this thesis was recovered from Test Unit 1 of the East Ravine Site of the Louisville Swamp Survey. Test Unit 1 is a part of a two by two meter block of test units placed to uncover the floor of the lithic workshop. The location of test units and shovel tests are confidential to ensure site preservation. Site location information access can be gained through the USFWS.

In the 2017 field season, soil was dry shifted through a quarter inch screen and remaining material field sorted into broad cultural categories. In 2018, we continued to field screen excavated soils and due to muddy soil conditions, collected all that remained in the screen to be then washed and then sorted in the lab. This allowed for a higher and more confident recovery rate for the 2018 collection. Additionally, bulk samples of 10 cubic centimeters were recovered from the block excavation and processed in the lab which allowed for the presence of micro-debitage in the lithic assemblage.

## *Laboratory Methods*

All recovered materials were sorted into cultural and non-cultural categories. The collection was then cataloged with the accession number MNV3.023 in preparation for storage at the archaeological repository at the Minnesota Historical Society's History Center. Once the cataloging process was done, the assemblage was able to be analyzed with debitage specific methods. This is a factor of why the sample size (n=468) did not include all debitage from the site as it was simply not possible for research at this scale. This sample size made it possible to capture data from a portion of the site that we can assume will reflect the patterns of the other three units in the two by two meter block.

Debitage analysis is a method used to gather information from the debris (flakes and shatter) produced by chipped stone tool production (Carr and Bradbury 2001: 126). Stone tool production debris is essential to understanding pre-contact sites and their means of occupancy. This methodology calls on Binford's (1979) notion of Middle-Range theory as it bridges the analytical data collected from lithic debitage with behavioral theories about Native American lifeways before Euro-American settlement. Debitage analysis allows researchers to investigate the stone tool production which is key to a lithic-focused site like the Louisville Swamp (Pecora 2001:173). Despite chip stone technology accounting for the majority of artifacts recovered, Louisville has very few stone tools. Its assemblage shows signs of early stage lithic reduction and it is probable that the worked lithics were completed at another location within or beyond the workshop site. In applying debitage analysis to the lithic assemblage, we can understand the broader patterns of the site including the procurement of raw materials and technologies used.

There are three main approaches to debitage analysis: aggregate, flake typologies, and an attribute approach. Each of these approaches focus on different aspects of debitage due to the methods employed and build off one another in the detail and time invested.

Aggregate approaches to debitage analysis sort a lithic assemblage into standardized categories and then analyzes them in lots. This method often uses size (length and width) the main category of sorting. Aggregate approaches are effective when recording weight, size, and count as those are metric measurements that are considered reliable and makes it so one can infer the stage of production (Andrefsky 2001: 3). This approach to debitage analysis has proved useful as it allows for less error in data collection because it prioritizes metric measurements and is more time effective when working with larger assemblages. The aggregate approach to debitage analysis, however, does not account for the production technology nor the goals of production as all this data combined into a mass analysis when using specific classifications for sorting into lots (Andrefsky 2001: 4).

The next debitage analysis methodology focuses on the particular type of reduction. Typology analysis captures individual flake data and uses behavioral inferences based on established archaeological/experimental archaeology findings to assign debris into specific reduction categories. These categories could pertain to the stage, goal, or process of production. Andrefsky (2001: 6) identifies four subgroups to this approach to debitage analysis: application load, technical, cortex, and freestanding typologies. Application load investigates the force and tools used to detach the flake from the raw material package (Andrefsky 2001: 7). The technological typology approach looks at the kind of reduction occurring with respect to bifacial thinning, retouching, bipolar reduction, and notching (Andrefsky 2001: 7). The cortex typology measures the dorsal cortex percentage and links that to the reduction sequences (primary, secondary, and tertiary flakes) (Andrefsky 2001: 7). Finally, the freestanding approach to debitage analysis builds the typology through independent observations with inferences to technology and reduction (Andrefsky 2001: 7). Sullivan and Rozen (1985) argue that the typological approach is not consistent nor reliable enough in its definitions and needs to be replicable in its results. Analyzing pressure flaking is a great example of this issue as there are not clear parameters to the criteria of its analysis between researchers and their theoretical assumptions (Andrefsky 2001: 8).

Lastly, there is attribute analysis. This approach to debitage analysis requires the researcher to collect data on multiple characteristics on each flake in the research sample and is quite the investment. These attributes include flake class, dorsal cortex percentage, and platform types and angles. This aligns with Shott's (1994) call for analysis focusing on size and form that inform on production sequences and artifact types because lithic production is a reductive process (Andrefsky 2001: 11). The attribute analysis approach is used by Hamline University's Archaeology Laboratory to collect data on lithic assemblages and allows for productive comparison between assemblages. Letting the data patterns remain objective in their association with specific reduction sequences and technologies, researchers can more broadly infer connections between lithic reduction and debitage patterns.

Ideally, the results of the debitage analysis of the Louisville Swamp assemblage would be compared to experimental data on bifacial lithic reduction sequences. Unfortunately, there is little published data on experimental archaeology so to supplement this role, I will use three sites with other lithic strategies a comparisons. These include three sites from Cottonwood County, Minnesota: the T. Thompson Site (21CO50), South Slough Site (21COxx), and Gruenig Site (21CO68). These three sites, along with the Louisville Swamp Site, all contain different lithic assemblages for local and non-local materials with a spectrum of lithic reduction stages from early to late-stage production. The Louisville Swamp Site is assumed to be an example of early-stage production as it is a lithic workshop utilizing the locally abundant PDC chert with debitage of Cottonwood County exotic materials being on the late-stage end of the reduction continuum which I expect to consist of late-stage flakes and tool resharpening flakes (Hoffman and Seaberg-Wood n.d.).

Sullivan and Rozen's (1985) Formal Approach of recording a minimum attribute set is closely followed by the Hamline University Archaeology Lab Debitage Analysis Protocol (Hoffman *et al* 2019). Weight, raw material, cortex type, cortex percentage, platform angles (both interior and exterior), platform type, and flake class (including shatter) are all included in Sullivan and Rozen's set. Hamline's protocol adds weight, size grade, thickness, and termination to include size and form analysis following Shott (1994). The preliminary identification of thermal alteration (based on the presence of pink or red coloring) is also included to further understand the processes of lithic reduction. The Hamline University Archaeology Lab has established a methodology for each attribute recorded in the debitage analysis protocol (see *Debitage Analysis Methodology* by Hoffman *et al,* N.d. for descriptions of each attribute).

## Attributes for Analysis

The following attributes are essential to the results of the analysis in understanding how the flintknappers of the Louisville Swamp were utilizing PDC chert and through what means.

### Raw Material

Formal lithic raw material identifications were made using categories described by Bakken (2011, 2015) and Morrow (1994). Comparative collections from Hamline's archaeology lab were used to assist with the identifications, along with assistance from Dan Wendt and Kent Bakken. Raw material is a way to understanding how the organization of technologies was present at a site because raw material informs on lithic strategy and economy. The recording of this attribute helps to frame the workings of an archaeological site and assemblages within a broader context.

### Cortex Percentage and Cortex Type

Cortex identification and percentage are key to understanding lithic reduction processes. For this analysis, dorsal cortex was based on the percentage observed and is broken up into five categories: 0% (A), 1%-50% (B), 51%-99% (C), 100% (D), and platform only (E). Cortex percentage is inversely linked with the stages of reduction**--** as a flake is worked into its desired result, the amount of cortex significantly decreases (Andrefsky 2001: 11).

The cortex types identified follow the lithic waste analysis protocol laid out by Sullivan and Rozen (1985). Cortex types were categorized and recorded by three main categories which were then broken down into subcategories for a more complex understanding of each assemblage. These categories are cortex exhibiting mechanical weathering (waterworn, polished, and smooth), chemical weathering (patinated and chalky), and other types (unaltered bedrock, stained, and coarse). Each of these categories gives context to raw material sourcing and the ways in which they are obtained.

## Flake Class

Flake class categorizes the completeness of debitage following Sullivan and Rozen (1985). There are four categories: waste flake complete (WFC), waste flake broken (WFB), waste flake fragment (WFF) and shatter (WSH). WFC has an intact platform and termination, meaning the flake's ventral and dorsal surfaces can be identified. WFB has an intact platform but has termination that has broken off and is not representative of the original length and size of the flake. WFF is debitage that is missing the platform but has identifiable ventral and dorsal surfaces. WSH is debitage that has two ventral surfaces, which is associated with bipolar reduction. (Shott 1994; Sullivan and Rozen 1985).

## Platform Type

Shott (1994) has suggested the importance of platform type. The platform is where the lithic raw material was struck with force to detach the flake. Depending on the tool used to accomplish this, as well as the stage of production, the flake will have a different platform (Roth 2001: 16). Platform type was only recorded when the flake class was categorized as complete or broken. The platform was observed and recorded as cortical (COR), single (SGL), double (DBL), multiple (MPL), bipolar (BIP), crushed (CRU), and indeterminate (IND).

## Interior Platform Angle

Interior platform angle allows analysts to understand how the material was hit and detached. The interior platform angle can reinforce the suspicions of platform type and the technology used by the flintknapper. (Hoffman *et al* 2019*).* Interior platform angle was recorded to the nearest five degrees using a metal protractor.

## Thickness

Debitage thickness was recorded to the nearest hundredth millimeters using electronic calipers. Thickness was measured at the thickest point on the debitage.

## *Process Reflection*

This process offered fluid learning and evaluation of categories as the project progressed. In both subjective categories such as cortex type and metric categories such as platform type, I had to be educated in what it meant and how to identify it properly before I could confidently record it. For example, you have to understand a striking platform before you can identify its type before you can measure it properly.

While the majority of attributes collected in the debitage analysis held up when compiling the metadata of the Louisville swamp assemblage, thermal alteration and cortex type could be used. The recording of thermal alteration through the presence of pink coloring gave false positives, making the collection of this attribute unreliable. Furthermore, there is little understanding of how the various PDC chert types react to heat treatment (Wendt 2014: 8-9). For reliable data collection on thermal alteration, researchers would need to utilize experimental data for each type of PDC chert. The recording of cortex type was problematic due to lack of comparative specimens, which made the identifications subjective and thus, not reliable. Flakes needing raw material identification were pulled for expert analysis with a portion remaining unidentified. Additionally, partway through this and associated projects, there was much deliberation of interior versus exterior platform angles. The Hamline University Archaeology Lab decided to only use interior platform angles in the checking of collected debitage analysis data which could skew the accuracy and availability of interior platform angle results.

Each flake's debitage analysis results were checked by Forest Seaberg-Wood and Brian Hoffman and are reliable data sets.

# *Results*

## Assemblage breakdown

The Louisville Swamp Survey is comprised of lithic artifacts including debitage, cores, few bifaces, tested raw materials, hammerstones, fire-cracked rock, etc., as well as a small number of faunal remains and grit-tempered pottery body sherds (Table 1).

| **Total Louisville Swamp Artifact Count by Manufacturing Technology** | | | |
|---|---|---|---|
| **Chip Stone Technology** | | | |
| Biface | 2 | Core fragment | 1 |
| Biface fragment | 1 | Debitage | 2731 |
| Bipolar core-tool | 3 | Non-bipolar core tool | 1 |
| Cobble tool fragment | 1 | Patterned biface | 1 |
| Core | 5 | Tested raw material | 43 |
| **Total Chip Stone** | | | **2784** |
| **Ground Stone Technology** | | | |
| Abrader fragment | | | 1 |
| **Total Ground Stone** | | | **1** |
| **Pecked Stone** | | | |
| Anvil | 1 | Hammerstone | 10 |
| Battered rock | 3 | | |
| **Total Pecked Stone** | | | **14** |
| **Molded Materials** | | | |
| Bullet casing | 2 | Sherd | 5 |
| **Total Molded** | | | **8** |
| **Non-cultural Materials** | | | |
| Broken Rock | 435 | Natural rock | 26 |
| Charcoal | 1 | Remains | 10 |
| Limestone | 19 | Rosy Limestone | 31 |
| Natural chert cobble | 126 | Sample | 7 |
| Fire-cracked rock | 163 | Unidentified lead object | 1 |
| **Total non-cultural material count** | | | **820** |
| **Total artifact count** | | | **3627** |

*Table 1 shows the total artifact count for the Louisville Swamp Survey Catalog as of April 10, 2019.*

Although this lithic workshop site is located where PDC chert is naturally abundant, the emphasis on PDC materials at the site is still surprising given the material's relative poor quality.

The Louisville assemblage has less variety in raw materials utilized, which could be a product of the lithic reduction sequence or the lack of suitable raw materials available to flintknappers.

Debitage analysis was applied to 468 flakes that were excavated from Test Unit 1. This is almost all of the lithic debitage excavated from Test Unit 1 in 2017 and 2018 field season. Each piece of debitage was analyzed individually according to the attribute approach previously discussed.

## Expectations

The following are my predictions for how the Test Unit 1 debitage assemblage will compare against Hoffman and Seaberg-Wood's Lithic Strategy Models (Hoffman and Seaberg-Wood n.d.):

*Model 1: Tested Raw Material Strategy*
*Model 2: Core-Flake Strategy*
*Model 3: Biface Strategy (3A: Early; 3B: Late; 3C: Complete)*
*Model 4: Tool Maintenance Strategy*

- Dorsal Surface Cortex Percentage
    - I predict that Model 1 debitage assemblages would have a high percentage of flakes with 50-100% dorsal surface cortex (types C & D).
    - I predict that Model 3C debitage assemblages would have a high percentage of flakes with no cortex (type A) given that non-cortical flakes are more prevalent in late-stage production.
    - I predict that Model 4 debitage would have no cortical flakes present in the assemblage.
- Thickness
    - I predict that debitage assemblages associated with Model 2 would have a greater maximum and average thickness than late-stage reduction models (Model 4), but thinner than debitage assemblages following Model 1.
- Platform types
    - I predict that Model 3A debitage assemblages would have a high percentage of multiple faceted platforms.
    - I predict that Model 2 debitage assemblages would have a high percentage of cortical, crushed, and single faceted platforms.
- Platform angles
    - I predict that Model 3A debitage assemblages would have a higher presence of high-level (120 degrees and greater) interior platform angles, especially as associated with multiple faceted platforms.
    - I predict that Model 2 debitage assemblages would have a greater presence of low-level interior platform (less than 90 to 100 degrees), as associated with cortical, crushed, and single faceted platforms.

## *Louisville Swamp Attributes*

### *Flake Class*

Sullivan and Rozen (1985: 758-760) identify flakes and shatter to be an attribute that can infer flintknapping techniques. They highlight that core-flake reduction (Model 2) is often associated with complete flakes and shatter, while broken flakes are more abundant in bifacial reduction assemblages (Models 3a-c) (Myster 1996: 19; Shott 1994: 78; Sullivan and Rozen 1985: 763). The Louisville swamp best fits Model 2, particularly in the shatter and complete flake categories (Table 2).

| | **Louisville Swamp Debitage** |
|---|---|
| **Flake Class** | **PDC chert (n=443)** |
| **Complete** | 23.0% |
| **Broken** | 16.9% |
| **Flake Fragment** | 47.0% |
| **Shatter** | 13.1% |

*Table 2: Test Unit 1 flake class breakdown.*

### *Dorsal Cortex Presence*

Debitage from the Louisville Swamp fits into all the categories of dorsal cortex coverage with C and D being notable at this lithic workshop site (Table 3). The percentage of flakes that are majorly or fully cortical dorsal cortex surfaces at Louisville affirm there are early-stage reduction techniques occurring in this landscape and connect it to local quarrying activities.

| | **Louisville Swamp** |
|---|---|
| **Cortex** | **PDC chert (n=177)** |
| **A (0%)** | 42.9% |
| **B (1-50%)** | 35.4% |
| **C (51-99%)** | 14.0% |
| **D (100%)** | 7.7% |

*Table 3: Dorsal cortex presence on complete and broken flakes. The sample size represented is only complete and broken flakes. This allows the data to be comparable with debitage data from 21HE483.*

*Thickness*

The flakes from Louisville Swamp are thick (Table 4) which could indicate early-stage reduction because as the reduction sequence continues, the flakes typically get thinner.

| Thickness (MM) | Louisville Swamp PDC chert (n=177) |
|---|---|
| Max | 29.43 |
| Avg | 4.99 |
| Min | 0.4 |

*Table 4: Maximum, average, and minimum complete and broken flake thickness. Only complete and broken flakes are represented to make data comparable with debitage data from 21HE483.*

Platform types are an indicator of the stage of lithic reduction as different platform types. Cortical platforms are associated with early-stage reduction whereas multiple faceted platforms are associated with bifacial technology (Brian Hoffman, personal communication 2019). A high percentage of cortical platforms indicates that there is early stage production occurring at the site. The Louisville Swamp assemblage has a low percentage of multiple faceted platforms and a high percentage of single faceted and cortical platforms (Table 5).

| Platform types | Louisville Swamp PDC chert (n=443) |
|---|---|
| **Multiple Faceted** | 5.6% |
| **Single Faceted** | 65.3% |
| **Crushed** | 8.5% |
| **Cortical** | 20.5% |
| **Bipolar** | 0.0% |

*Table 5: Lithic Assemblage breakdown by platform type.*

*Interior Platform Angle*

Interior Platform angles in Table 6 are separated in to low, mid, and high level categories. Early-stage reduction is associated with lower interior platform angles with angles increasing as the reduction sequence continues. Louisville Swamp has a high percentage of mid-level angles that place the site vaguely in the middle of the reduction sequence.

| | | Louisville Swamp |
|---|---|---|
| **Interior Platform Angle Categories** | **Interior Platform Angles** | **PDC chert (n=168)** |
| **Low level** | **<90** | 6.0% |
| | **90-100** | 12.5% |
| **Mid-level** | **101-110** | 28.6% |
| | **111-120** | 19.0% |
| **High level** | **121-130** | 13.1% |
| | **130+** | 5.4% |

*Table 6: Measurable interior platform angles broken into low, mid, and high level angle groupings. Only measurable platforms from complete and broken flakes are represented.*

# Discussion

## Hypotheses

Based on the attribute analysis results above, I hypothesize that the Louisville Swamp Site is a lithic workshop site focused on early-stage reduction (following Models 2 and 3A). The workshop site is near a primary source of PDC chert and acts as a provisioning space for flintknappers returning to their home base, whether that be local or non-local. To confirm or disprove this hypothesis, I will compare the Louisville assemblage to assemblages following other lithic strategies.

## Comparison to Other Lithic Strategies in Minnesota

Comparing debitage analysis results against other Minnesota pre-contact sites with other lithic strategies will help the interpretation of debitage patterns at Louisville Swamp. University's Archaeology Lab has been conducting research on two other archaeological pre-contact lithic sites: South Slough site and Gruenig site, both from Cottonwood County, Minnesota (Hoffman and Seaberg-Wood n.d; Klumb n.d.; Seaberg-Wood *et al* .2017). In addition to these two sites, I am also comparing the Louisville swamp assemblage to data from 21HE483, a pre-contact lithic site along the Minnesota River in Bloomington, Minnesota (Bakken 2018). The lithic patterns of these three assemblages suggest the following reduction strategies at each site:

1. South Slough PDC chert represents Model 3B as a late-stage reduction of a non-local material.
2. South Slough Swan River chert represents Model 3C as a finished product of a local material.
3. All Cottonwood County exotics represent Model 3B or 4. [i]
4. Gruenig Site PDC chert represent Model 3B as a late-stage reduction of a non-local material.
5. 21HE483 materials represent Model 1 as testing of local materials and taking workable materials off-site for further reduction.

## Attribute Analyses

The following attributes and comparisons give the strongest evidence for the Louisville Swamp being an early-stage (Model 2 or 3A) lithic workshop site with a special focus on PDC chert.

### Raw Material

The raw material percentages present in the Louisville assemblage demonstrate a singular focus on PDC chert at this workshop site (Table 7).

| *Raw Material* | Count | Percentage of Assemblage |
|---|---|---|
| **Basalt** | 2 | 0.40% |
| **Chert** | 11 | 2.40% |
| **Gunflint Silica** | 1 | 0.20% |
| **Igneous Other** | 1 | 0.20% |
| **PDC chert** | 443 | 94.70% |
| **Quartz** | 2 | 0.40% |
| **Swan River chert** | 8 | 1.70% |
| **Grand Total** | **468** | **100.00%** |

*Table 7: Raw material breakdown of Louisville Swamp Survey Test Unit 1.*

The lithic assemblage analyzed from the Louisville Swamp Survey aligns with the raw materials in the Hollandale resource region as defined by Kent Bakken (2011; 2015). There are no identified exotic materials in my assemblage. Additionally, the non-PDC chert materials, local and non-local, are extremely rare in the assemblage. The analysis of Test Unit 1 debitage identified PDC chert as being 94.7 percent of the recovered debitage materials. This is 3.7 percent higher than the maximum percentage of PDC chert previously recorded in the Hollandale resource region as well as any other site in the Minnesota (Bakken 2011: Table 3-4). See Table 8 for a direct comparison.

| Hollandale Resource Region (from Bakken 2011 table 3-4) | | | Louisville: Test Unit 1 |
|---|---|---|---|
| PDC chert Minimum | PDC chert Mean | PDC chert Maximum | PDC chert present |
| 4.4 % | 44.8 % | 91.00% | 94.70% |

*Table 8: Direct comparison between PDC chert percentages in Hollandale Resource Region and Louisville Swamp's test unit 1 debitage.*

Although the models used in this thesis do not address lithic raw material distributions in any given assemblage, this data provides evidence of the Louisville Swamp being a workshop associated with a nearby quarry that focused almost exclusively on PDC chert.

### *Flake Class*

The Louisville swamp best fits Model 2, particularly in the shatter and complete flake categories. All materials analyzed at South Slough and Gruenig follow Model 3 of bifacial reduction with a high percentage of broken flakes. The exotics at Cottonwood County are difficult to interpret with the relatively equal distribution among the Sullivan and Rozen (1985) categories. (Table 9)

| | Louisville Swamp | South Slough | | Cottonwood Co. | Gruenig |
|---|---|---|---|---|---|
| **Flake Class** | **PDC chert (n=443)** | **PDC chert (n=144)** | **SRC (n=81)** | **Exotics (n=35)** | **PDC chert (n=50)** |
| **Complete** | 23.0% | 10.4% | 14.8% | 31.4% | 12.0% |
| **Broken** | 16.9% | 40.3% | 32.1% | 28.6% | 44.0% |
| **Flake Fragment** | 47.0% | 47.9% | 46.9% | 40.0% | 38.0% |
| **Shatter** | 13.1% | 0.7% | 6.2% | 0.0% | 6.0% |

*Table 9: Lithic assemblages' distribution of flake class. Data in the table above and tables following use data from Louisville Swamp Survey, the South Slough Site (see Klumb n.d.), Cottonwood County (see Klumb n.d.; Seaberg-Wood et al. 2017; Seaberg-Wood n.d), and the Gruenig Site (see Seaberg-Wood n.d).*

### *Dorsal cortex presence*

The data from raw material and flake class distributions suggest Louisville Swamp is an early-stage lithic workshop site where chert nodules were worked. Dorsal cortex presence is a highly diagnostic attribute to expand on predictions about reduction strategies at this site. Table 10 shows that Louisville has more cortical flakes than the Cottonwood County sites and less cortical flakes than the tested cobble site at 21HE483.

| | Louisville Swamp | South Slough | | Cottonwood Co. | Gruenig | 21HE483 |
|---|---|---|---|---|---|---|
| **Cortex** | **PDC chert (n=177)** | **PDC chert (n=78)** | **SRC (n=38)** | **Exotics (n=21)** | **PDC chert (n=28)** | **All 2016 raw materials (n=109)** |
| **A (0%)** | 42.9% | 78.1% | 85.5% | 81.0% | 57.1% | 29.3 % |
| **B (1-50%)** | 35.4% | 17.8% | 5.3% | 9.5% | 39.3% | 20.2 % |
| **C (51-99%)** | 14.0% | 2.7% | 5.3% | 4.8% | 3.6% | 21.1 % |
| **D (100%)** | 7.7% | 1.4% | 0.0% | 4.8% | 0.0% | 23.9 % |

*Table 10: Results of dorsal cortex percentage comparison. Only data from complete and broken flakes is represented.*

Louisville Swamp Survey does not have the debitage patterns of the Model 3C (finished biface), or Model 4 (tool resharpening) nor Model 1 (cobble testing). 21HE483 has a significantly higher percentage of D category debris and a much lower percentage of non-cortical debris as predicted in Figure 4a. Based on this data comparison, we can determine that the flintknappers at the Louisville Swamp were going beyond testing the local PDC chert and working it to some degree.

The 3C model (finished biface) also does not apply to this assemblage because Gruenig site's PDC chert (which is a non-local material to the area) debris has a much higher amount of non-cortical flakes implying that late-stage production is occurring. The lack of D and C categorized flakes at this site reinforces the idea that PDC is prepared into a biface or blank before flintknappers take it to or trade it to the Woodland tradition Native culture in Cottonwood County.

The dorsal cortex percentages from PDC chert of South Slough Site align with the expectations laid out by Model 3C with a higher presence of non-cortical flakes and a lower presence of cortical ones. I expected Swan River chert to share reduction patterns with the PDC chert at Louisville because they are both local to their areas but, instead it has even less dorsal cortex present than the South Slough site's non-local PDC chert. This means the model of reduction for Swan River chert does not mirror Louisville.

The South Slough's exotics being completely non-cortical are consistent with the norms around exotic materials' late-stage reduction. This leaves me to hypothesize that the Louisville Swamp flintknappers are either working locally abundant PDC chert into core-flakes (Model 2) or bifaces (3A).

*Thickness*

Core-flake reduction (Model 2) should have a greater thickness in flakes as the flakes detached should be sizable enough to further work and refine into a desired tool or for a desired use. Early-stage biface reduction (Model 3A) should also have relatively thick flakes compared to late-stage biface reduction (Model 3B). The Louisville Swamp debitage, again, aligns with Model 2 and potentially Model 3A (Table 11).

| | **Louisville Swamp** | **South Slough** | | **Cottonwood Co.** | **Gruenig** | **21HE483** |
|---|---|---|---|---|---|---|
| **Thickness (MM)** | **PDC chert (n=177)** | **PDC chert (n=78)** | **SRC (n=38)** | **Exotics (n=21)** | **PDC chert (n=28)** | **All 2016 raw materials (n=109)** |
| Max | 29.43 | 13.8 | 11.1 | 7.3 | 17.1 | 47 |
| Avg | 4.99 | 3.72 | 3.3 | 3.46 | 4.33 | 10.6 |
| Min | 0.4 | 1.2 | 0.5 | 0.7 | 0.9 | 1 |

*Table 11: Results of flake thickness comparison. Only data from complete and broken flakes are represented.*

Model 2 fit this comparative data fairly well as PDC chert from Louisville Swamp has the thickest flakes as expected compared to the Cottonwood County sites. Louisville Swamp, of course, has thinner flakes than 21HE483 because this site's lithic process was only testing and taking workable materials off-site to be further utilized.

Louisville Swamp is projected to be the earliest stage production of PDC chert against the Cottonwood County sites but could still hold a variety of reduction stages which would account for the minimum thickness at Louisville. Raw material package size and the flintknapper's expected product influence the thickness of the flake, with early-stage reduction needing to work material more to achieve the desired product.

### *Platform Type*

Table 12 shows Louisville having a higher percentage of cortical platforms than all comparative sites, reaffirming that this is an early-stage reduction site associated with a local PDC chert quarry. The Cottonwood County's PDC chert assemblages have a greater presence of multiple faceted platforms which aligns with patterns of non-local raw materials.

| | **Louisville Swamp** | **South Slough** | | **Cottonwood Co.** | **Gruenig** |
|---|---|---|---|---|---|
| **Platform types** | **PDC chert (n=176)** | **PDC chert (n=75)** | **SRC (n=37)** | **Exotics (n=22)** | **PDC chert (n=29)** |
| **Multiple Faceted** | 5.6% | 20.0% | 13.5% | 9.1% | 3.4% |
| **Single Faceted** | 65.3% | 65.3% | 56.8% | 68.2% | 75.9% |
| **Crushed** | 8.5% | 10.67% | 16.2% | 4.8% | 17.2% |
| **Cortical** | 20.5% | 4.0% | 13.5% | 9.5% | 3.4% |
| **Bipolar** | 0.0% | 0.0% | 0.0% | 4.8% | 0.0% |

*Table 12: Results of platform type comparison.*

My predictions are largely supported by this data. Louisville Swamp had lower percentages of multiple faceted platforms when comparing to the Southwestern Minnesotan sites' non-local PDC chert and exotics. The higher presence of cortical, crushed, and single faceted platforms at Louisville are more aligned with Model 2 (core-flake reduction). The only oddity is the low percentage of multiple faceted platforms at Gruenig which may be the result of a differing lithic strategy than the PDC chert at South Slough.

## *Summary of Discussion*

The amount of PDC chert in the Louisville Swamp lithic assemblage is impressive at 94.7 percent and sets the new maximum percentage for the material in Bakken's (2011) Hollandale resource region as well as any site in the state of Minnesota. Based on the breakdown of the assemblage and the presence of coarse or rough (bedrock) cortex, we can assume this workshop is associated with a local quarry.

The three strongest results for the Louisville Swamp assemblage are dorsal cortex percentage, thickness, and platform type. These attributes give clear indication of early-stage reduction at the Louisville workshop site. This assemblage has more fully or majorly cortical dorsal cortex percentage, greater maximum and average thicknesses, and more cortical platforms than the comparative sites in Cottonwood County. Additionally, the high percentage of complete flakes and lithic shatter at Louisville are associated with core-flake reduction. This strengthens the argument that the Louisville Swamp site is a core-flake reduction site (Model 2) associated with a local PDC chert quarry.

The negative data at the Louisville Swamp site is another factor that impacts interpretation. There were very few lithic tools recovered, meaning they were probably taken off-site to be used or further worked. If all lithic materials produced at this site were left in situ for archaeologists to interpret, we could confidently identify the technological organization, but the lack of bifacial tools is not yet understood. If Model 2 of core-flake reduction is an accurate identification of the Louisville Swamp site, then there should be no negative data of bifacial reduction to consider. Myster (1996: 19) explains that bifacial reduction should exhibit a higher ratio of bifaces to cores or cobbles than core-flake reduction and core-flake reduction will have a high number of unretouched flakes that were used as expedient tools. Louisville currently aligns with the latter.

A possibility to explain the complexities of this data is the varying types of PDC chert from different formations and members that may be present at the swamp site. Our analysis did not address PDC chert types as individual raw materials or collect attributes linked with these types. Perhaps there are differing methods of lithic reduction according to the specific type of PDC chert and its quality. Wendt's (Personal communication 2019) ongoing research highlights the over-reporting of PDC chert and the under-reporting of its different groups that have extremely different flintknapping capabilities. Based on my experience with this assemblage and the visible difference in the types of PDC chert utilized, it is highly probable that flintknappers are using a variety of PDC chert types in hopes of finding the highest quality. Perhaps different types of PDC chert were used in different reduction sequences, which would account for the broad range we see in the analysis. The lack of material analysis is likely contributing to the complexities in our data and is necessary for the successful continuation of this research. Other focuses of future research should address the process of heat treatment within the lithic reduction sequence. My current research was not able to encompass this because of the complicated identification of PDC chert types that Wendt's (2014; 2019) ongoing research has highlighted.

## *Cultural Importance*

This excavation came out of the collaboration of the US Fish and Wildlife Service's Regional Archaeologist and Historic Preservation Officer, James Myster, and Hamline University's Anthropology Department with the intention to preserve cultural and historical heritage and resources. This work protects the site from possible future development and destruction under the *National Historic Preservation Act* and preserves the unexcavated *in situ* materials of this lithic workshop site in the swamp's landscape.

Spector's (1993) work at the nearby Little Rapids site archaeologically records the narrative of historic Dakota lifeways at the seasonal planting site. Through her collaboration with the descendant Dakota community, she was able to build further narratives of this landscape's cultural importance. I hope to see the research at the Louisville Swamp build to that level of collaboration and accessibility for the local Native American communities. Currently, it brings a new archaeological narrative of Native American lifeways to how the USFWS manages and interprets the land for visitors. It also implements the opportunity to collaborate with the Shakopee Mdewakanton Dakota Sioux Community in these efforts, giving the tribe space to control the cultural narrative of their ancestral communities and reclaim aspects of their tribal homeland.

The Shakopee Mdewakanton Dakota Sioux Community's Director of Cultural Resources, Leonard Wabasha (personal communication 2018), visited the site during the 2018 field season and shared that he felt a strong connection to this landscape. This swamp and its surrounding landscape has been an important part of Indigenous lifeways and narratives for centuries. Wabasha wishes to bring this narrative forward as a part of a walking or digital tour of the Dakota peoples' homeland to bring visibility and accessibility to Native American history and heritage. Furthermore, these publicly-placed interpretations would make the somewhat esoteric results of lithic analysis more accessible for all audiences and add perspective to the everyday experience of the Native American flintknappers in space, place, and activity.

Personally, I have found it extremely humbling to work with this assemblage so closely and have often wondered if my reactions to the quality, color, or texture of a given flake of PDC chert were the same as those working it thousands of years ago. Debitage analysis served to capture the human behavior that produced this debris and went further to allow me as a researcher to experience each flake—not only as a piece of information but as a connection to a group of people who had extremely different lives and realities than mine. I hope to see others take on this research to further our knowledge of how ancient flintknappers used this space, its material, and their intentions in doing so to further the cultural heritage and preservation practices around this landscape.

## *Conclusion*

This process has been one of academic growth. I began this project with little knowledge of lithic reduction and debitage analysis protocol and methodology but learned through the process, as is the norm in the anthropological discipline. The investigation of the lithic reduction strategies at the Louisville Swamp Site has allowed me to understand the protocol and methodology of debitage analysis but also how it can be strengthened for future research. This holds true to the importance of using experimental debitage data to address questions of lithic reduction technologies in the sites we excavate as archaeologists.

This thesis is based on the lithic analysis of 468 flakes from test unit 1 of the Louisville Swamp Survey from the East Ravine (MNV3.023). Excavations in the five test units produced over 2,731 flakes, making test unit 1 debitage an accessible research sample. The total number of flakes recovered to present is yet to be determined due to the ongoing cataloging process. The findings of this research greatly contribute to Hamline University's Anthropology Department's current work in understanding how PDC chert moves throughout Native American landscapes in Southwestern Minnesota and allows for comparison to a localized PDC workshop site for the pre-contact lithic sites in the area. Beyond Hamline University's research initiatives, this research makes an important contribution to the broader work of Minnesota archaeology. The Louisville Swamp site brings perspective to how lithic strategies, and in turn, Native lifeways, organized around PDC chert's availability. My findings act as a piece of the puzzle in understanding the reduction sequence and valuing of this curious lithic raw material and help build a foundation for future research endeavors on the material.

The Louisville Swamp Site has been the focus of the research within the Hamline University Archaeology Lab for the past two years, and it will continue to be excavated and analyzed in upcoming years. Through all of my time spent on this project in the artifact recovery, processing, analysis, and interpretation, I have questioned the intentions of this workshop space. Its identification as a primary source PDC core-flake reduction site allows it to be used in future comparative as an example of early-stage reduction. More importantly, understanding the lithic technology at Louisville allows for a variety of questions to be explored. I often wondered what learning to flintknap would be like at this PDC chert workshop site given its poor workability, or even what flintknapping in this space sounded and felt like. Understanding the lithic reduction technologies utilized in this landscapes allows for these types of questions to be considered and answered through replication and the intersection of anthropological methodologies. All of this would build understandings of Native lifeways and experiences prior to Euro-American settlement.

## *Acknowledgements*

I feel so humbled to have worked with the material culture of people working in the Louisville Swamp some thousands of years ago. Spending so much time with the lithic materials these flintknappers created made me think a lot about their day to day lives, what made the time pass while they worked, what they laughed at, etc. In a way, it pushed me to bring empathy and reflection to my analysis of lithic remains and for that I am very grateful.

This research would not have been possible without Professor Brian Hoffman, who pushed me in and out of the classroom to grow in archaeology, research, and all the good that came with it. I have benefitted beyond words from the opportunity to participate in his research, classes, and work in his lab. One day I will buy the Dairy Queen after a fun day out in the field!

I am so grateful for Forest Seaberg-Wood, who oversaw much of the success of this project in all aspects with her expertise and her unwavering support. Hannah Klumb has been a fantastic research colleague throughout this process; it has been such a privilege to grow in the discipline alongside her. Many thanks to the James Myster and the USFWS for their collaboration with Hamline on this project, and for the grant money that has secured my work in managing this collection as a student researcher that has allowed so much professional growth.

This results of the Louisville Swamp Site's debitage analysis would not have been clear without the guidance of Minnesota lithic raw materials experts Kent Bakken and Dan Wendt. Dan Wendt's ongoing research on PDC chert and other lithic raw materials has been particularly informative to my project and the Hamline University Archaeology Lab as a whole, for which we are extremely grateful.

Finally, huge thanks go out to the Hamline students who excavated these materials in the 2017 (Sadie Bartlet, Hannah Hensley, Hannah Klumb, McKenzie Nelson Martin Peper, Danielle Sortor, and myself) and 2018 (Paige Daniels, Delaney Grundhauser, Kao Lou Her, Kelley Lasiewicz, Elizabeth Ronald, John Seidl, Claire Witt, and teaching apprentices: Hannah Hensley, Hannah Klumb, and myself) Hamline University Archaeology field schools, as well as the USFWS Regional Archaeologist, James Myster and staff Rikka Bakken (2017) and Martin Peper (2018). Thanks to all the students who helped process collection as a volunteer in the Hamline Archaeology Lab and as a student in Professor Hoffman's *Archaeology Laboratory Techniques* course. Thanks Liz Ronald for creating the PDC chert type flowchart.

I am so excited to see what will come next for the Hamline Archaeology Lab and the people who call it their home on campus. I am glad to graduate knowing Louisville is in good hands. Find

Lastly, thank you to all my friends and family who have supported me throughout this process. I am so grateful for the unconditional space, love, and support you have given me to make all of this happen. Cheers to what is next!

# References Cited

Andrefsky Jr., W.
2001 Emerging Directions in Debitage Analysis. *Lithic Debitage: Context, Form, Meaning,* edited by Andrefsky J., W. University of Utah Press.

Bakken, K. E.
2011 Lithic Raw Material Use Patterns in Minnesota. Ph.D. dissertation, University of Minnesota, Minneapolis.

2015 Chapter 6: Chipped Stone Tools. Section In Morrow, T. *Stone Tools of Minnesota*, Wapsi Valley Archaeology, Inc. Anamosa, Iowa.

2018 "Lithic Analysis" and "Appendix A: Analysis of the General Lithology and Toolstone Components of a Quarried Cobble and Gravel Deposit at 21HE483" sections In Florin *et al. Additional Phase II Evaluation at Site 21HE483 for the Replacement of a Parking Lot Adjacent to the Long Meadow Bridge in Hennepin County, MN.* FCRS Reports of Investigation 126. Florin Cultural Resources Services, LLC Boyceville. Report prepared for MnDOT. Copy on file at MnSHPO.

Binford, L. R.
1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255-273

Carr, P.J. and Bradbury, A. P.
2001 Flake Debris Analysis, Levels of Production, and the Organization of Technology. *Lithic Debitage: Context, Form, Meaning,*edited by Andrefsky J., W. University of Utah Press.

Fish, R.
1981 Beyond Tools: Middle Paleolithic Debitage Analysis and Cultural Inference. *Journal of Anthropological Research* 37:374-386.

Gibbon, G.
2003 *The Sioux: The Dakota and Lakota Nations.* Blackwell Publishers. Malden, MA.

2012 Archaeology of Minnesota: the Prehistory of the Upper Mississippi River Region. University of Minnesota Press, Minneapolis.

Gonsior, LeRoy
1992 Lithic Materials of Southeastern Minnesota. *The Platform: A Publication of the Minnesota Knappers Guild* 4(1):5–7.

Hiscock, P. and Mitchell, S.
1994 Stone artefact quarries and reduction sites in Australia: towards a type profile. Archaeology in Oceania, 29: 110-111.

History of the Shakopee Mdewakanton Sioux Community. *Shakopee Mdewakanton Sioux Community*. N.d.

History. *Scott County, MN*. N.d.

Hoffman, B.W. and Seaberg-Wood, F.
Lithic Strategy Models. On file at Hamline University. N.d.
Debitage Analysis Protocol. On file at Hamline University. N.d.

Hoffman, B.W, Seaberg-Wood, F., Klumb, H., and Marshall, A.
Debitage Analysis Methodology. On file at Hamline University. N.d.

Hudak, G. Joseph
1979 *Volume II: A Cultural Resources Check and Archaeological Investigation of the Minnesota River Valley Refuge Lands*. Archaeological Field Services, INC. Stillwater, Minnesota. Report prepared for US Department of the Interior and USFWS.

Klumb, H.
2019 *A Lithic Analysis at a Southern Minnesota Site: South Slough Site*. On file, Anthropology Department, Hamline University, St. Paul, MN.

Marschner, F.
1974 *The Original Vegetation of Minnesota: Complied from the U.S. General Land Office Survey Notes.* Map published by the North Central Forest Experiment Station, St. Paul. Originally published in 1930.

Minnesota Office of the State Archaeologist
2016 Prehistoric Period. *Minnesota Office of the State Archaeologist*. December 3.

Morrow, T.
1994 A Key to the Identification of Chipped-Stone Raw Materials found on Archaeological Sites in Iowa. *Journal of the Iowa Archeological Society* 41: 108-129.

Myster, J.
1996 A “Weighted” Methodology for Determining the Lithic Reduction Technologies at Six Galena Chert Acquisition Sites in Fillmore County, Minnesota. *The Minnesota Archaeologist* 55:16-33.

Ojakangas, R. and Matsch, C.
1982 Minnesota’s Geology. Minneapolis: University of Minnesota Press.

Percora, A. M
2001 Chipped Stone Tool Production Strategies and Lithic Debitage Patterns. *Lithic Debitage: Context, Form, Meaning,* edited by Andrefsky J., W. University of Utah Press.

Seaberg-Wood, F.
Gruenig Site (21CO68) Debitage Data. On file, Anthropology Department, Hamline University, St. Paul, MN. Laboratory n.d

Seaberg-Wood, F., Hoffman, B.W., Sanders, T., Broste, C., and Weber Darnell, L.
2017 The Red Rock Ridge Survey: Results of the 2016-2017 Field Season. Hamline University Anthropology Department.

Shott, Michael
1994 Size and Form in the Analysis of Flake Debris: Review and Recent Approaches.” *Journal of Archaeological Method and Theory* 1:69–110.

Spector, J.
1993 *What This Awl Means: Feminist Archaeology at a Wahpeton Dakota Village.* Minnesota Historical Society Press, St. Paul.

Sullivan, A. P. and Rozen, K. C.
1985 Debitage analysis and archaeological interpretation. *American Antiquity*, 50: 4, 755-779.

(USFWS) US Fish and Wildlife Service
2018 About the Refuge and the Wetland Management District-Minnesota Valley- U.S. Fish and Wildlife Service. *U.S. Fish and Wildlife Service*. Accessed April 6, 2018.

Web Soil Survey
2017 Soil Conservation Service with cooperation of the Minnesota Agricultural Experiment Station, United States Department of Agriculture. Web Soil Survey.

Wendt, D.
2014 PDC Group Chert Resources of the Upper Mississippi River Valley in Southeastern Minnesota and Far Western Wisconsin. *The Minnesota Archaeologist* 73: 75-89.

2019 Stone Tool Making Survival Skills on the Minnesota Prairie: Marginal Lithic Material Use, Available Choices, Compromise and Need for Long Distance Connections to High Quality Sources. Paper presented at the 2019 Council for Minnesota Archaeology proceedings, St. Cloud, MN.

Wikipedia Contributors
2019 Minnesota River. *Wikipedia*. Wikipedia: The Free Encyclopedia, April 7.

2018 Minnesota Valley National Wildlife Refuge. *Minnesota Valley National Wildlife Refuge*. Wikipedia: The Free Encyclopedia, October 5.

Withrow, R.M.
1983 *An analysis of lithic resource selection and processing at the Valley View site,(47 LC 34)*. Diss. University of Minnesota.

Whittaker, J.C.
1993 *Flintknapping: Making and Understanding Stone Tools*. University of Texas Press, Austin, TX.

Wright, H.E., Jr.
1972 Physiography of Minnesota. *In Geology of Minnesota: A Centennial Volume*, edited by P.K. Sims and G.B. Morey. Minneapolis: Minnesota Geological Survey, University of Minnesota.

---

[i] Exotic materials from South Slough, T. Thompson, and the Gruenig sites have been complied to provide a larger sample size for comparative purposes (see Klumb n.d.; Seaberg-Wood et al. 2017; Seaberg-Wood on file, Hamline University Archaeology Laboratory n.d). Exotic materials include Maynes Creek, Burlington, and Iowa cherts, as well as Knife River Flint and Hixton Quartzite.